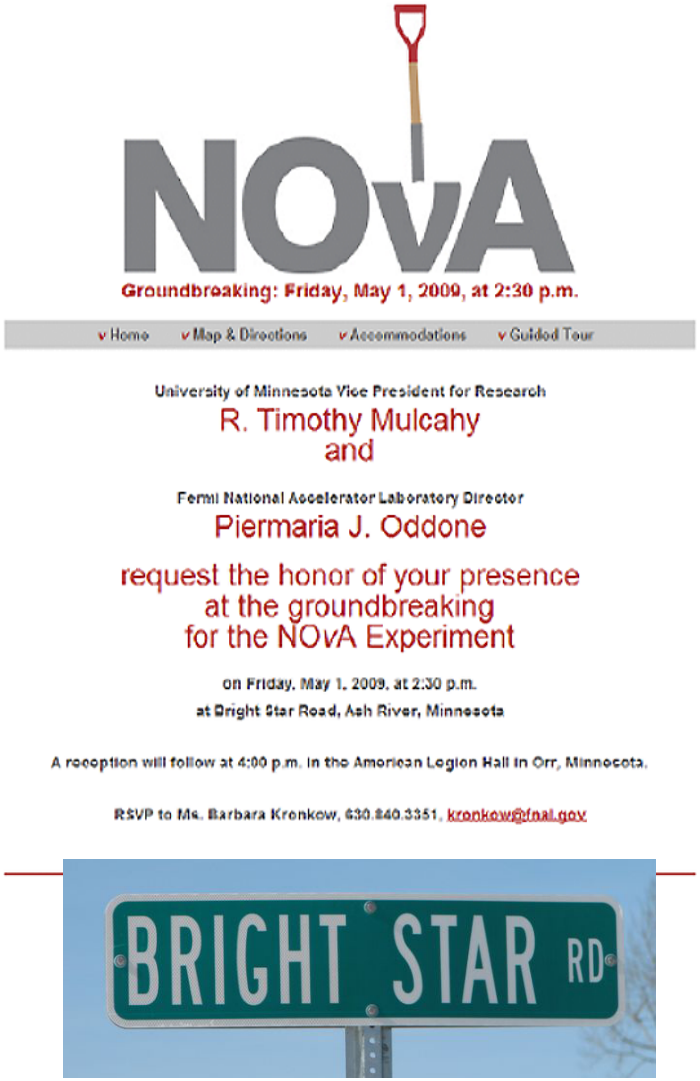

NOνA Update
Collaboration Meeting
Argonne National Laboratory
24 April 2009
Gary Feldman
Image from Google

# Perspective

- A lot has changed in the past six months. Two meetings ago in October 2008, my update had two slides discussing the possibility that NOνA would be canceled.
- Now we have $83M in FY09 funds.
- However, remember that the TPC of $278M has not changed. We have just moved from back-loaded funding to front-loaded funding.
- In fact, the total funding may be worse because the EVMS certification is threatening to charge the TPC for scientists' salaries. This is a potential $12M to 22M problem.
- We need to review decisions previously made for cash flow reasons.

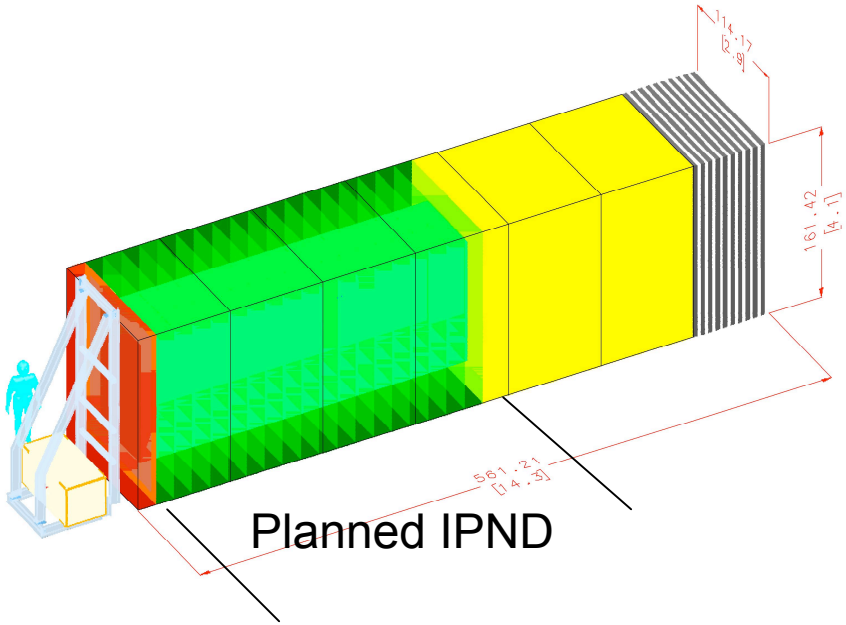
# Far Detector Site and Building

- One such decision was to move forward on the whole site and building package.
- Six bids were received and the top two contractors are being interviewed today in Minneapolis.
- We expect the contract to be awarded next Tuesday.
- Ground breaking at Ash River a week from tomorrow.



# IPND/Near Detector (1)

- Another decision that involve cash flow was to build only 4 of the 6 modules of the Near Detector for the IPND.
- Now, it clearly makes sense to build it all the modules at this time.




- The full near detector, with the muon catcher would make a much better IPND. However, it will not fit into the MINOS surface building.

# IPND/Near Detector (2)

- So, should we take on the added expense of building a separate enclosure?
- If so, what sort?  John has suggested that we build one out of shielding blocks so that we can test the planned Far Detector overburden.
- Our Calibration Committee is studying these issues.

# IPND/Near Detector (3)

- John also raised the issue of the NuMI beam:
  - After the summer shutdown, MINOS wants two years of antineutrino running (but could change its mind if it decides it can be competitive in $\nu_\mu \rightarrow \nu_e$). This would probably reduce the IPND rate by a factor of 3.
  - MINER$\nu$A, on the other hand, wants all neutrino running after it commissions it detector.
  - The current second-floor decision is that MINOS can run antineutrinos until June 2010, but, of course, this could change.

# Assembly Issues

- At our last meeting, we were concerned over technical issues in handling and gluing modules. We are happy to see that these issues have now been resolved. This morning's demonstration was very impressive.
- Looking forward to the completion of the FSAP and FHEP, both critical to test our assembly plans.

# Computing

- Since the last meeting, Mayly Sanchez has replaced Peter Shanahan as offline computing coordinator.
- There was a Computing Workshop in March to start coordinating common interests of neutrino experiments. This was organized (in part) by our new collaborator Heidi Schellman and our new CD liaison Lee Lueking. Report tomorrow afternoon.

# Speakers Committee

- Since the last meeting we established a Speakers Committee
  - Maury Goodman (chair)
  - Carl Bromberg
  - Craig Dukes
  - Ken Heller
  - Karol Lang
  - Gina Rameika
- They have been drawing up a set of guidelines, which will be discussed by both the IB and the ExCom.

# Supplementary Funding

- At the request of DOE/HEP, we circulated a solicitation for requests for supplementary funding. We did not directly rank the requests, but commented on the importance of each to the project and experiment.
- This was followed up by a direct request to PIs at each institution for a prioritized list of requests. As far as I know, HEP is still working on this.
- This also helped to clarify the contributions of various institutions. Ohio, Northern Illinois, and Rio de Janeiro have withdrawn from the collaboration. There are additional inactive institutions, which will be discussed with the IB.

# Upcoming Events

- May 1 — Ground breaking at Ash River
- May 11-15 — EVMS review
- June 16-18 — Director's CD-3b review
- July 15-18 — Collaboration meeting at Fermilab
- July 21-23 — DOE CD-3b review

# Some Physics from String Theory

- I usually do not pay attention to theoretical predictions in this field because they are usually not based on anything more than numerology. However, a colleague of mine, Cumrun Vafa and his students have recently done some work that I find quite interesting.
- They have used string theory and two simple assumptions to make no-free-parameter first-order estimates of the quark and lepton mixing matrices. And the CKM predictions are dead-on.
- The references are [hep-th] arXiv:0811.2417 (quarks), [hep-ph] arXiv:0904.1419 (leptons), and [hep-th] arXiv:0904.3101 (CP violation).

# Assumptions

- The assumptions: (called F-Theory)
  - A GUT exists.
  - Particle physics is not changed in the absence of gravity (i.e., the Planck mass $\rightarrow \infty$).
- Surprisingly, with these assumptions, both string theory and possible GUTs become quite restrictive.
- The only parameter is $\alpha_{GUT}$ and this is determined from running the measured coupling constants to the GUT scale: $\alpha_{GUT} = 0.04$.

# Quark Predictions

- For the quarks, the CKM matrix is estimated to be

$$V_{CKM} \approx \begin{pmatrix} 1 & \alpha_{GUT}^{1/2} & \alpha_{GUT}^{3/2} \\ \alpha_{GUT}^{1/2} & 1 & \alpha_{GUT} \\ \alpha_{GUT}^{3/2} & \alpha_{GUT} & 1 \end{pmatrix} = \begin{pmatrix} 1 & 0.2 & 0.008 \\ 0.2 & 1 & 0.04 \\ 0.008 & 0.04 & 1 \end{pmatrix}$$

compared to the measured values

$$\begin{pmatrix} 0.97 & 0.23 & 0.004 \\ 0.23 & 0.97 & 0.04 \\ 0.008 & 0.04 & 0.99 \end{pmatrix}$$

# Neutrino Predictions (1)

- Leptons are different from quarks due to the GUT-level right-handed neutrino. (But some Dirac models give the same results).
- Predictions:
  - Normal mass ordering with $(m_1, m_2, m_3) \propto (\alpha_{GUT}, \alpha_{GUT}^{1/2}, 1)$.
    - $\Rightarrow \Delta m^2_{atm} \approx 30\ \Delta m^2_{sol}$ . Data = 31±2.
    - $\Rightarrow m_1 \approx 0.002$ eV. Probably unmeasurable.

# Neutrino Predictions (2)

- The PMNS matrix is predicted to be

$$V_{PMNS} \approx \begin{pmatrix} U_{e1} & \alpha_{GUT}^{1/4} & \alpha_{GUT}^{1/2} \\ \alpha_{GUT}^{1/4} & U_{\mu 2} & \alpha_{GUT}^{1/4} \\ \alpha_{GUT}^{1/2} & \alpha_{GUT}^{1/4} & U_{\tau 3} \end{pmatrix}$$

  - $\Rightarrow \theta_{23} \approx \theta_{12} \approx 27^{o}$. Data : $\theta_{12} = 34 \pm 1^{o}; \theta_{23} = 45 \pm 7^{o}$.
  - $\Rightarrow \theta_{13} \approx \theta_{C} \approx 12^{o} \Rightarrow \sin^2(2\theta_{13}) \approx 0.15$.
  - Note that this suggests that $\sin^2(\theta_{23}) < 45^{o}$, which implies that we will see a smaller signal than the reactor experiments after taking the matter effect into account.

# Neutrino Predictions (3)

- When I queried Cumrun on CP violation, he first said that they had no prediction, but then realized that they could estimate the magnitude of the Jarlskog invariant, $J$ ,

$$J = \frac{1}{8}\sin^2(2\theta_{12})\sin^2(2\theta_{13})\sin^2(2\theta_{23})\cos(\theta_{13})\sin(\delta)$$

- When they estimate $J$ for the quarks, they get $|\sin(\delta)|\approx 1$, which agrees with the data, $\sin(\delta) = 0.93$.
- For neutrinos, they first calculated a small value for $\delta$, but it was then pointed out to them that they ignored important cancellations in the calculation. The corrected result is that $|\sin(\delta)|\approx 1$ for neutrinos as well.